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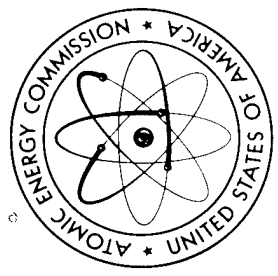
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A-Bomb Human Casualties in a Building
Located Less than 200 m from the
Hypocenter
A-Bomb Disaster Investigation. 1. Disaster Investigation within Tunnel Type Air
Raid Shelter in Hill near Nagasaki Prison

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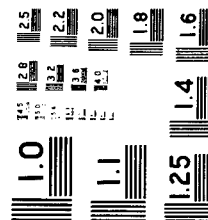
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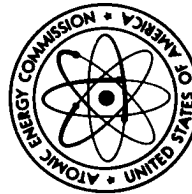
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PROTECTION BY CONCRETE AGAINST A-BOMB RADIATION
SICKNESS IN HIROSHIMA CITY

By
Koichi Murachi

*Retyped
See attached*

Translated from Collection of Investigation Reports
on Atomic Bomb Disaster, Volume 1, 467-77; 483-6(1953).



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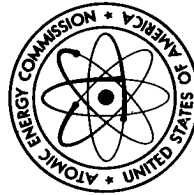
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TRANSLATION SERIES

AEC-tr-6858

SELECTED ARTICLES FROM THE COLLECTION OF
INVESTIGATION REPORTS ON ATOMIC BOMB DISASTER,
VOLUME 1, 1953.

Translated from a Japanese book entitled
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PROTECTION BY CONCRETE AGAINST A-BOMB RADIATION
SICKNESS IN HIROSHIMA CITY

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Faculty of Medicine, Tokyo University

Collection of Investigation Reports on Atomic Bomb Disaster,
Vol 1, 1953, pp 467-477, 483-486.

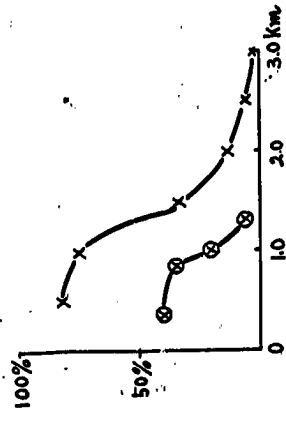


Fig. 1. Incidence of RS and distance
from the bomb center in Hiroshima.
x -- Within the general area; ○ --
within concrete buildings.

It is well known that the incidence of radiation sickness (hereafter abbreviated RS) among people who were in solid buildings at the time of the atomic bomb explosion in Hiroshima was far below that of people in the same area who were not in these same buildings. The curve marked x in Fig. 1 gives the RS incidence in the general area while the ○ curve gives the

incidence among people who were in concrete buildings. It was observed that concrete afforded considerable protection against RS. These curves represent average values, and there were many instances in which some people within a given concrete structure were affected by RS while others in the same structure were unaffected. It is evident that concrete attenuated the radiation from the blast. Representative concrete structures at various distances from the blast center were selected for more detailed study.

The sites selected for this study are the buildings shown in Fig. 2. They include 1. Bankers Club (280 m), 2. Hiroshima Branch, Bank of Japan (280 m), 3. Central Telephone Office (500 m), 4. Chugoku Power Building (800 m), 5. JOFK Studio (1000 m), and 6. Communications Office and Hospital (1350 m). (The figures in parentheses give the horizontal distance to the blast center.)

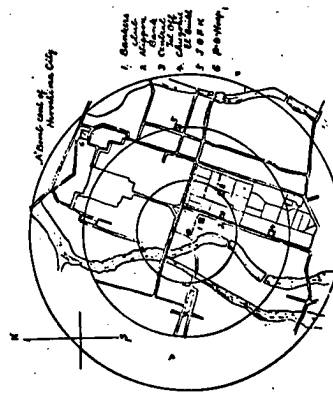


Fig. 2. Locations of buildings investigated.

(The center represents bomb center, the other circles are spaced 500 m apart.)

The floor plan of each floor of every building was obtained or drawn up, and the true positions of the occupants of each room at the time of the blast were plotted. At the same time, the fate of each individual was noted. This was not a simple procedure in view of the general confusion that

resulted from the blast. We were fortunate in obtaining deep service from the American troops so that we could range wide areas looking for the patients and concerned people. Despite our efforts, only a total of about 600 people were interviewed.

The families of dead people were called upon to obtain the details leading to the deaths. When this was not possible, their friends were called upon to supply the details. Survivors were interviewed directly, and the questions asked included the general health condition, incidence of RS, loss of hair, mouth injury, nose injury, bleeding gums, and subcutaneous bleeding. In each place the individual's room, floor, or passageway that he was occupying at the moment was noted. Figs. 3 and 4 give representative examples of this distribution. The locations of the people in the JOFK Studio and the Chugoku Electric Building and their fates are summarized in Table 1, and the legend of the symbols in the table are given in Fig. 5. The number placed alongside each individual in these figures gives the card number. A Roman numeral indicates the information was obtained directly from the individual concerned or his family while the Arabic numerals indicate the information was obtained from friends. \otimes and \odot indicate people who contracted RS in which the information was obtained directly from the patient or his family. The former symbol signifies the patient was living and the latter a patient who had died. The dot on the circumference indicates the direction this individual was facing at the time of the blast. We next used these floor plans to try to determine the effective degree of shielding the people received from the concrete walls, floors, and ceilings were made. Where the radiation did not enter normal to any of these dividing sections, the effective thickness corresponding to the angle of incidence was calculated. Depending on the direction and angle of the blast, the radiation could have passed through a single or several concrete layers, and errors in the shielding calculations could easily result. To avoid the possibility of this type of error, a transparent floor plan of each level was made, and the complete assembly was aligned with the blast center. Let us take the example of the FK Studio. The plans for the first story, second floor, and roof were constructed and stacked up (Fig. 3 d), and the location of each individual on this three dimensional plan was accurately marked to facilitate the determination of the effective shielding thickness. This procedure was followed in calculating what effective thickness of concrete at a building a given distance in meters from the blast center gave protection against RS. We again use the FK Studio as an example. Looking at the roof of this

Fig. 3 (a)-(d). Injury sites at the JOFK Studio.
(The arrows indicate the direction of the radiation)

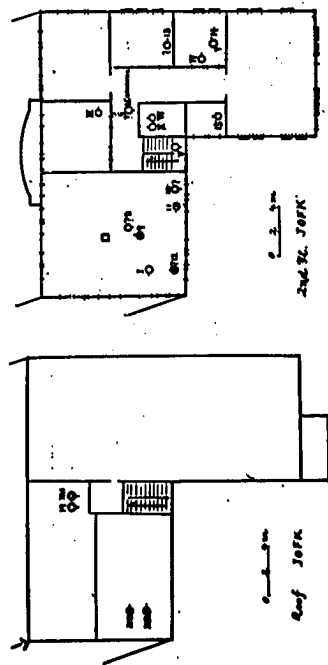


Fig. 3 (a) Top Floor

Fig. 3 (b) Second Floor

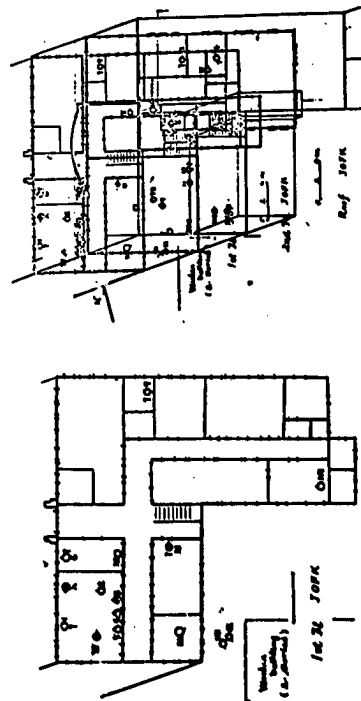


Fig. 3 (c) First Floor

Fig. 3 (d) Transparent View.

Fig. 4 (a)-(f). Injury sites at the Chugoku Electric Building.

(The arrows indicate the direction of the radiation)

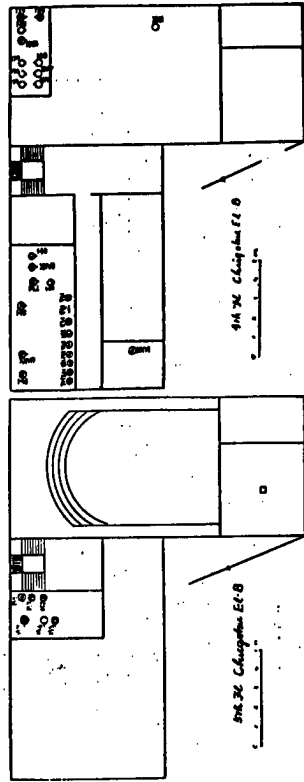


Fig. 4 (a) Fifth Floor

Fig. 4 (b) Fourth Floor

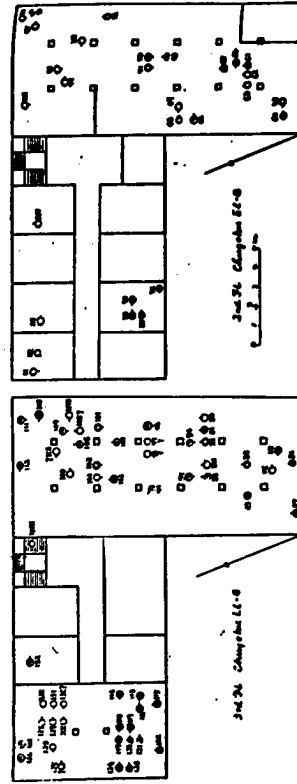


Fig. 4 (c) Third Floor

Fig. 4 (d) Second Floor

(Fig. 4 continued)

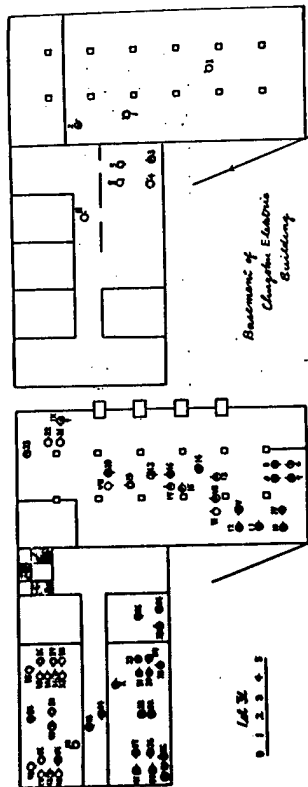


Fig. 4 (e)

Fig. 4 (f)

building (Fig. 3 a), ⑩ and ⑪ were killed by exposure to the fireball. Both were stripped and had been wiping their bodies when they were exposed to the flash from the right. ⑫ XVII and ⑬ XIV were in the wooden addition with concrete walls that had been placed on the roof and were exposed to radiation through one concrete wall but not to the fireball. Both began to lose the hair on their heads from about the end of August. The effective shielding by the concrete for these two as determined by the method previously cited was 18 cm. (The outside of this addition had burned, and the thickness of the wood was subtracted from the thickness of the remaining concrete wall. The angle of incidence of the radiation upon this wall was taken into consideration for calculating the effective thickness): ⑭ X and ⑮ XV who were on the first floor (Fig. 3 c) developed RS, and XV died on September 13. As seen from the floor plan of Fig. 3 d, these two must have been standing by windows to be in the direct path of the radiation. The RS situation of people at other sites was not clear. It can be deduced that an effective concrete thickness of 30 cm would prevent RS at this distance from the blast. The results obtained in a similar manner for the Chugoku Electric Building are shown in Table 2. These results show that people shielded with more than 100 cm of concrete did not develop RS while 80-90 cm could not prevent RS. The safe effective thickness for each site determined in this manner is given in Table 3.

Table 1

Summary of Injuries at the Chugoku Electric Building (see Fig. 4)

M... Building to the right facing Fig. 4,
W... Building to the left

Chugoku Electric Building

	Total	Living						Dead				missing
		total	intact	R.S.	inj	burn	unk	total	imm D	R.S.	inj	
Basement	M	3	1					2	1		1	
	W	5	2		1			3		1	2	
1st Fl	M	24	16		12(3?)			7	6		1	1
	W	37	19	6	7(3?)		5	17	6	5	6	
2nd Fl	M	21	16	2	4	8	2	5	1		4	
	W	8	7	1	3			1				
3rd Fl	M	31	19		6	5	8	10	4	2	4	2
	W	24	17	4	8?		1	7	3	4(1?)		
4th Fl	M	11	9		2(1?)	7		2	2			
	W	17	12		9(1?)		3	3		2	1	2
5th Fl	M	0										
	W	6	4		1	1	2	2	1		1	

○ no injury
◎ developed RS
◎ received external injury
◎ unknown
○ died instantly
◎ died from RS
◎ died from external wounds

Fig. 5. Code describing the type of injury.

The radiation flux in the air at various distances from the point directly below the blast is shown in Fig. 6, and this can be considered the radiation attenuation curve in air. This dose was calculated using the number of neutrons, energy, and air attenuation factors deduced from the radioactivity of phosphorus in human bones and sulfur in fences from various parts of the city of Hiroshima along with the biological standard that a dose of 1000 r of γ radiation would cause loss of hair.

Table 2

Loss of Hair by Survivors in the Chugoku Electric Building and Thickness of Concrete....People Investigated Directly

- no signs of RS
- ⊙ survived but suffered loss of hair (Roman numerals are case numbers)

Concrete wall thickness	
30 cm	
40 "	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV
50 "	⊙ XIV ○ XIV ○ XIV ○ XIV ○ XIV
60 "	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV
70 "	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV
80 "	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV
90 "	⊙ XIV ○ XIV ○ XIV ○ XIV ○ XIV
100 "	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV
110 "	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV
120 "	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV
130 cm	○ XIV ○ XIV ○ XIV ○ XIV ○ XIV

Table 3

Limiting Thickness for Safety from RS at Each Site

Name of Building	Distance from ground zero	real thickness of the concrete wall
1. Bankers' Club	280 m	200 cm?
2. Nippon Bank	380 "	?
3. Tel. Office	500 "	70 - 90
4. Chugoku Electric Comp. Building	800 "	50 - 80
5. J.O.P.K. Studio	1,000 "	18 cm

No set relation could be established between the incidence of RS and thickness of concrete shielding at the Bankers Club. This may be because most of the people here died either through injuries or RS and could not be checked more closely. We checked 34 survivors from about the 80 who were in the Bankers Club, and the lack of a consistent relation may mean we have to conduct another study on something other than the structural aspect.

Consistent results were obtained for the Telephone Office, Chugoku Electric Building, and the FX Studio, so these results were scrutinized further. From Fig. 6 the following dose values can be obtained:

Dose in air at the Telephone Office 10,000 r
Dose in air at the Chugoku Electric Building 4,600 r
Dose in air at the JOFK Studio 2,300 r

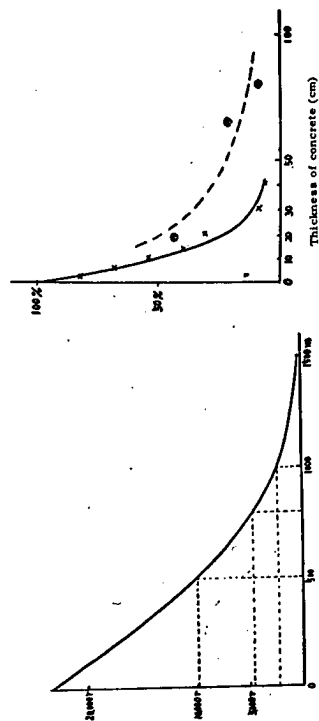


Fig. 6. External radiation dose at various distances in r units.

Fig. 7. Attenuation of radiation by concrete. ⊙ -- radiation from atomic bomb; x -- radium, gamma rays.

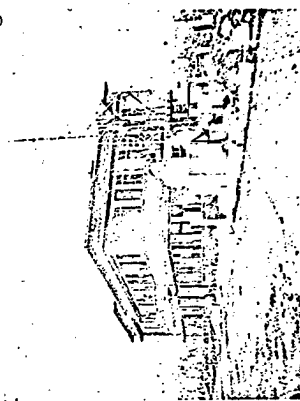


Fig. 8. The JOFK Studio after the bombing.

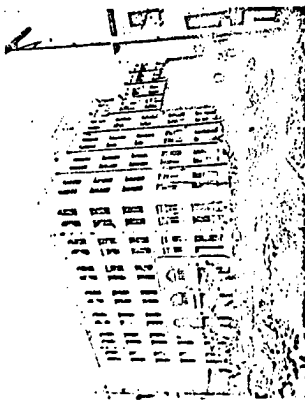


Fig. 9. The Chugoku Electric Building after the bombing.

The effect of time on the loss of hair by radium or gamma radiation was not considered but the value of 1000 r of gamma was taken to be coincident with the loss of hair as was mentioned before. Thus, 10,000 r at the Telephone Office was calculated to be reduced to 1000 r by 80 cm of concrete, 4500 r to 1000 r by 65 cm of concrete at the Electric Building, and 2300 r to 1000 r by 18 cm of concrete at the FK Studio. These were converted to percentages which are the points alongside the dotted line of Fig. 7. The solid line in the same figure is the attenuation curve of the gamma radiation from a radium needle used for medical purposes. This curve was determined experimentally after the field measurements. A comparison of the two curves shows that the degree of attenuation of the radiation from the blast was less than that from radium. (Figs. 8 and 9 show the bombed out FK Studio and Chugoku Electric Building).

The United States is carrying out a series of large-scale tests with regard to the bombing, and it is expected that detailed studies on the value of concrete as shielding material against radiation will be included. We do believe that this paper has significance in that it contains the results of studies made directly after the first atomic explosion in which the actual victims of the bomb were interviewed or investigated amid the confusion that existed. Note: The Central Telephone Office Data was compiled by Sato of the Kosei Scientific Laboratory.

A-BOMB HUMAN CASUALTIES IN A BUILDING LOCATED LESS THAN 200 m FROM THE HYPOCENTER

by Osamu Kitamoto of the Sakaguchi Internal
Medicine Department, Faculty of Medicine,
Tokyo University and Koichi Ishikawa of the
Otsuki Surgery Department, Faculty of Medicine,
Tokyo University

1. It was possible to make a rather detailed study of human casualties and the effects of radiation on a single body of a group of people who were in a building 160-180 m southeast of the hypocenter and about 600 m from the blast itself.
2. This building was of reinforced concrete construction whose roof was covered with 15 cm depth of water. The windows had steel shutters but about half of them were open at the time of the blast. There was no damage to the skeleton of the building as a result of the blast, but the ceiling of the third floor was bent and window glass was shattered. The materials in the rooms were completely burned by the resulting fire.
3. It is estimated that there were 60-70 people in this building at the time of the blast. It has been established thus far that at least 36 instantaneous deaths occurred. There were 28 who developed acute radiation sickness who died 6-25 days following the explosion. There were 23 cases from which blood samples were taken, and these all showed severe decrease in white cell count in the period August 10-14. The records show further that two out of two cases showed loss of hair, two out of four showed subcutaneous bleeding, six out of six showed gum damage and head and throat damage, and 26 cases in which temperature of 39-40°C was observed. We found there were at least two survivors, and personally interviewed one of them who was a switchboard operator to get a direct account. We were able to obtain a relatively complete blood test and bone marrow test. The

fate of the remaining 24 was not known up to November of 1945, and it is believed that the majority must have perished. The death rate is approximately $(36 + 28)/(36 + 28 + 2)$ or 97%.

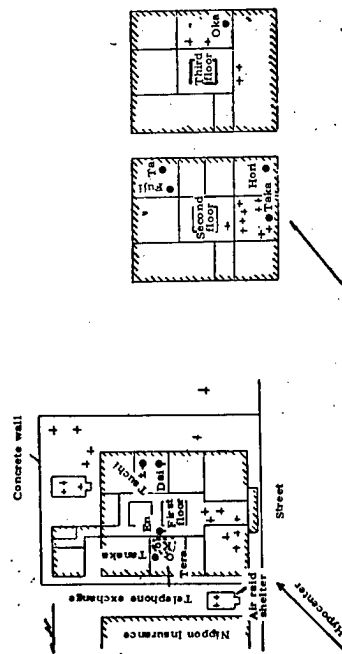


Fig. 1. First floor of the Hiroshima Bankers Club.

● -- Died later; ○ -- survivor; + -- instantaneous death.

Fig. 2. Second and third floors.

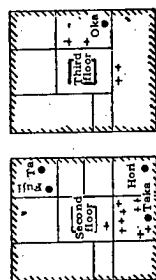
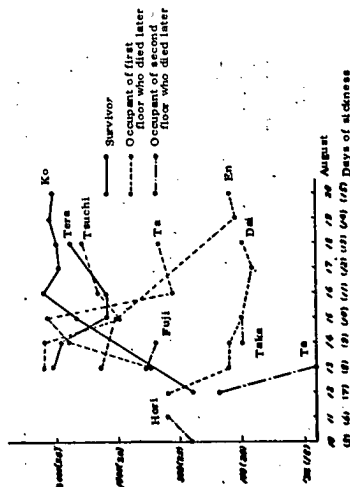


Fig. 3.



4. (1) The positions of two survivors and nine who later died have been established as well as those of the 36 instantaneous deaths. (2) The records of the survivors and those who died later were plotted. (3) The effects of the radiation on the survivors were clearly manifested in the form of loss of hair, decrease in white blood cell count, temperature, vomiting, subcutaneous bleeding, or menstrual irregularity. (4) There were three people in the telephone exchange room on the first floor at the time of the explosion of which two died. One of the reasons this person survived is that he was protected by more walls from the radiation.

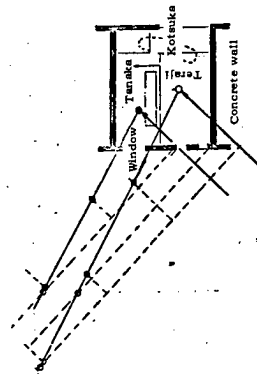


Fig. 4.

still others had the eyes popped out of their sockets. There were some from whom every stitch of clothing had been torn away.

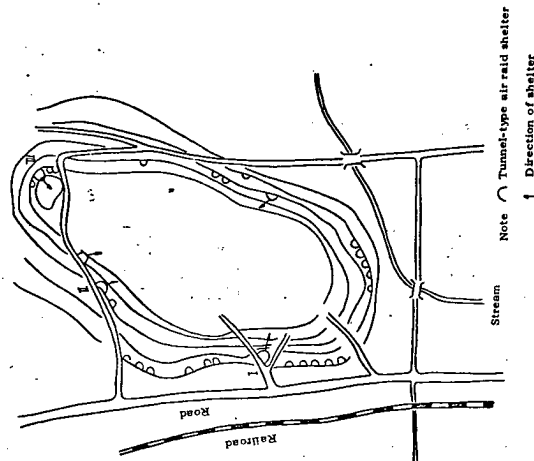


Fig. 1. Prison hill.

No. 2 Air Raid Shelter

This is a small shelter dug part way up the north slope (see Fig. 3). A girl had gone into this shelter to escape the heat temporarily and was in the spot shown in the figure. This girl received no wounds and was miraculously saved. She had fallen flat just about halfway into the shelter with her feet pointing toward the entrance, but all she received was the effect of a minor shock blast.

No. 3 Air Raid Shelter

This is a medium sized shelter dug partly up the northeast slope. At the time of the blast two people were

A-BOMB DISASTER INVESTIGATION

1. Disaster Investigation within Tunnel-Type Air Raid Shelter in Hill Near Nagasaki Prison

by Miyoshi Urabe, Shigeru Ohashi, Hideo Ueda, Saburo Hakamada, and Soshiro Nikaido of the Faculty of Medicine, Tokyo Imperial University

The Nagasaki Prison is located near the epicenter of the atomic bomb explosion. As a result, most of the people in this vicinity were killed instantaneously. The prison itself is located on a rise about 50 m above the surrounding plain. Several tunnel-type air raid shelters were dug into the side of this rise about the periphery. A few who were engaged in repair work and a few who by chance happened to be in the tunnel survived the blast. The air raid shelters dug into this hill were as shown in Fig. 1. Seven people in Shelter No. 1, one in Shelter No. 2, and two in Shelter No. 3 or a total of ten survivors were counted.

No. 1 Air Raid Shelter

This is the largest shelter located on the west slope at about the same altitude as the road. At the time of the blast, 52 men and women were engaged in removing water that had leaked into this shelter. Those deepest in the shelter were using hand pumps which sent the water out part way through a pipe from which point a bucket relay brought the water all the way out. The distances from the entrance are shown in Fig. 2.

All the people from the entrance to about halfway into the tunnel died, and the seven who were further in survived. The location of these survivors are shown on this chart. The types of injuries suffered by these survivors are listed in Table 1. The survivors related the morning after the explosion that there were about 40 dead bodies between the entrance and the halfway mark. Some had been burned, some had been bruised, others had internal organs exposed, and

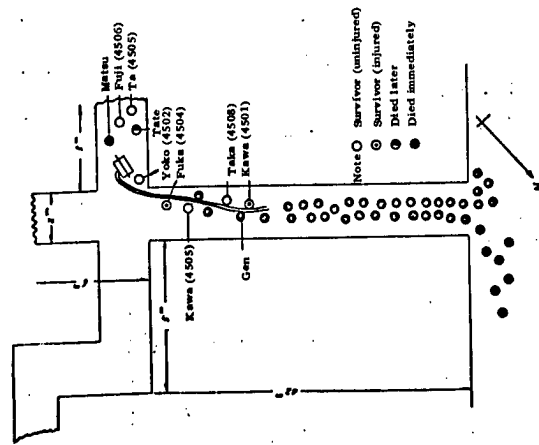


Fig. 2. No. 1 Air Raid Shelter.

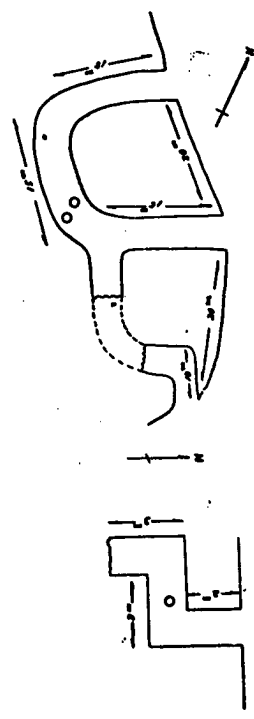


Fig. 3. No. 2 Air Raid Shelter.

Fig. 4. No. 3 Air Raid Shelter.

Table 1
Survivors in the Air Raid Shelters at the Prison

Case no.	Name	Sex	Age	Address	Remarks
No. 1 Air Raid Shelter					
4501	河 〇 子	♀	49	c/o Jinta, 238 Tateyama-cho	15% burns, exposure to radiation (4%)
4502	横 〇 幸	♀	20	61 Ninokawa-cho	light exposure to radiation (4%), presently healthy
4503	渡 〇 幸	♀	16	169 Okumachi	burns of face and legs and arms (no irradiation)
4505	田 〇 達	♂	13	c/o Yamashita, Inadomachi	practically unexposed to radiation
4506	藤 〇 子	♀	35	Nagoya (near Nagasaki)	details not known but presently healthy
4507	川 〇 幸	♀	60		burns to face and hands
4508	高 〇 市	♂	60		
No. 2 Air Raid Shelter					
4503	渡 〇 幸	♀	14	169 Okumachi	small cuts on face
No. 3 Air Raid Shelter					
4509	渡 〇 幸	♀	40	Kanbayashi	unexposed
4510	岩 〇 幸	♀	50		unexposed

engaged in repair operations at the sites shown in the figure. Both escaped unharmed and without radiation exposure (Fig. 4). It is believed that there is no need to consider the effects of the explosion through the walls of these air raid shelters built into the side of a rather large hill in the prison grounds. The size of the entranceway and the depth of the chamber along with the angular setting of this passageway with respect to the site of the explosion would be expected to be important items. These studies will be reported later.

END

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